

- kov, Moscow, and M. Rees, Cambridge),
- "The Neutral Interstellar Medium in Galaxies" (R. Genzel, Garching),
  - Assessments of the satellite projects Hipparcos and Hubble Space Telescope (M. Perryman, ESTEC, and F. Masetto, STScI),
- and, besides more than one hundred poster presentations, a substantial number of shorter communications.
- U. W. STEINLIN,  
Astronomisches Institut  
der Universität Basel, Switzerland

## New ESO Preprints

(September – November 1990)

### Scientific Preprints

725. J. Breysacher and C. Perrier: Decoding of the Light Changes in Wolf-Rayet Eclipsing Binaries: An Application to HD 5980 in the Small Magellanic Cloud. Invited contribution – IAU Symposium No. 143 on "Wolf-Rayet Stars and Interactions with Other Massive Stars in Galaxies". Denpasar (Bali), Indonesia, June 18–22, 1990.
726. G. Zhao and P. Magain: Abundances of Neutron Capture Elements in Metal-Poor Dwarfs. I. Yttrium and Zirconium. *Astronomy and Astrophysics*.

727. G. Piotto: Properties of the Globular Cluster Mass Functions. M. Stiavelli et al.: Disk-Shocking and the Mass Function of Globular Clusters. S. Djorgovski et al.: Color and Population Gradients in Globular Clusters. S.R. Zaggia et al.: Central Velocity Dispersion Measurements in M30 and Five Other Centrally Concentrated GGCs. To appear in *Formation and Evolution of Star Clusters* (ed. K. Janes), A.S.P. Conference Series, in press (1991).
728. P. Londrillo et al.: Dissipationless Galaxy Formation Revisited. *M.N.R.A.S.*
729. D. Bencivenni et al.: The Young Magellanic Cluster NGC 2004. *Astronomical Journal*.
730. E.A. Valentijn: Opaque Spiral Disks: Some Empirical Facts and Consequences. Invited paper presented at the IAU Symposium No. 144: "The Interstellar Disk-Halo Connection in Galaxies. Leiden, the Netherlands, June 1990. To be published in the Conference Proceedings. Ed. J.B.G.M. Bloemen, Kluwer, Dordrecht.
731. J.I. González-Serrano and E.A. Valentijn: A Rotation Curve Study of the Dwarf Sc Galaxy UGC 2259. *Astronomy and Astrophysics*.
732. D. Bettoni et al.: Stellar and Gas Kinematics of NGC 4546, the Double-Spin SB0. *M.N.R.A.S.*
733. R.M. West: A Photometric Study of (2060) Chiron and its Coma. *Astronomy and Astrophysics*.
734. R.M. West et al.: Commission 20: Positions and Motions of Minor Planets,

- Comets and Satellites (Positions et mouvements des petites planètes, des comètes et des satellites). To be published in IAU Transactions, Vol. XXI A, 1991.
735. A. Bragaglia et al.: Double Degenerates Among DA White Dwarfs. *Astrophysical Journal*.
736. R. Morganti et al.: The Nature of the Optical Filaments in Centaurus A: Evidence for a Beamed Ionizing Continuum. *M.N.R.A.S.*
737. A. Moneti and H. Zinnecker: Infrared Imaging Photometry of Binary T Tauri Stars. *Astronomy and Astrophysics*.
738. P.A. Patsis et al.: Self-Consistent Spiral Galactic Models. *Astronomy and Astrophysics*.
739. T. Zwitter et al.: Photometry of SS433 and its Implication on the Nature of the System. *Astronomy and Astrophysics*.
740. P. Bouchet et al.: The Bolometric Light Curve of SN 1987A. II. Results from Visible and Infrared Spectrophotometry. *Astronomy and Astrophysics*.
741. H.E. Schwarz: Discovery of a Nebula Around AS201. *Astronomy and Astrophysics*.
742. M. Capaccioli et al.: Empirical Correlations Between Globular Cluster Parameters and Mass Function Morphology. *Astronomy and Astrophysics*.

### Technical Preprint

26. L. Noethe: Use of Minimum Energy Modes for Modal Active Optics Corrections of Thin Meniscus Mirrors. *Journal of Modern Optics*.

## Cooperation in Astronomy in the New Europe

Report on a Panel Discussion at the XII ERAM in Davos<sup>1</sup>.

The initial interest for a discussion on this theme was much stimulated by the exceptional attendance from Eastern Europe. Clearly, the frame of this discussion was shaped by the opportunities offered by the new situation in the East, as well as by the increasing interest of the European Community in fundamental science, mobility and University programmes. Free circulation of people has now been achieved over nearly all of Europe (although some visa limitations still remain in force); English has emerged as a common language in astronomy, and while "all astronomers

are born equal", it is only now that equal opportunities progressively become a reality. It is the responsibility of the astronomical community to recognize its privileged life and to optimize the use of its costly resources in the most efficient manner, taking into account not only scientific, but also economic aspects. In the USSR, the difficulties related to the non-convertibility of currency creates problems, also for remote observatories, but the number of new projects (Radio-Astron, X- and Gamma-ray, 1.7-m EUV Telescope), which are open to international collaboration, should offer new opportunities.

The *mobility of people* is first addressed as a key issue in the construction of the new Europe. G. Setti underlines the existence of exchange programmes at the post-doctoral level, most often bilateral, sometimes within international agencies (ESA, ESO). He pleads for a vigorous extension of these

programmes, suggesting a goal for the astronomical community of 200 fellows per year, with a price tag of about 10 MDM/year. The most likely agent for a corresponding action is the European Community, which currently discusses its new Science programme (and especially the Line 6 – Human Resources and Mobility). One could envisage that Societies as the newly founded EAS may become partners of the EEC for such action, in order to reduce bureaucratic overloads. Exchanges must be balanced within Europe. To further this goal, it is suggested to create a limited number of focal points in Eastern Europe, which could channel the international exchanges. Reference is made to the virtue of a broad post-doc programme in the United States, since no tenured position is achieved without some exposure to mobility and to a context distinct from the one where the PhD was prepared.

<sup>1</sup> The Panel members were: A. Boksenberg (Cambridge), A. Boyarchuk (Moscow), P. Léna (Paris), R. Lüst (ESA), G. Setti (Bologna), J. Smak (Warsaw), R. West (ESO), F. Sanchez (Tenerife) and P.O. Lindblad (Stockholm) were unable to attend. In this short summary, opinions or comments are not necessarily referred to their actual author. The Chairman (P. Léna) takes the responsibility for his summary of the discussions, including remarks from the audience.

A. Boksenberg underlines how modern science, born in Europe, has a cultural richness which can be recognized by all Europeans acting in cooperation.

J. Smak makes a passionate plea for a balanced development where the "superpowers", in the astronomical sense, do not neglect the work which can be carried out in smaller institutes. All the best students should not leave the smaller institutes or countries, and a properly organized system of Visiting Professors or Lecturers could help to maintain the vitality of the smaller centres, given the present facilities of communication and decentralization. Small may remain beautiful!

R. Lüst points out how lucky the post-war generation has been to get post-doctoral opportunities in the United States on a broad scale, and how important this has been for the renaissance of science in Europe. H. van der Laan emphasizes the opportunities offered by the ESO Research Student Programme.

N. Bochkarev (Moscow) introduces the newly founded Soviet Astronomical Society, a professional society which intends to foster cooperation by disseminating information on fellowship programmes, evaluate projects, sponsor a new English-language publication, organize meetings, etc.

The second part of the discussion focuses on *Mobility of ideas and data*, in the framework of easier and faster communications. R. West describes the considerable changes that have taken place between "yesterday" when people went to the telescope to observe, and today, when the data come to the people, either from the telescope (remote observing) or from centralized data banks. An E-mail connection is a most important link to the rest of the world which any institute must ensure today; the recent, very positive experience in Warsaw is reported by J. Smak.

A key issue is data archiving. Data obtained on the ground are now coming at rates comparable to the ones obtained in space missions. And yet, their formatting is usually not so well defined, their archiving is of dubious nature or even absent, the right of access to astronomers not belonging to the observing teams is uncertain or with undefined rules. Defining formats, archives and rules of access in a professional way is an urgent task, especially in view of the advent of large, new telescopes and powerful detectors. Even existing data banks may not be sufficiently documented to offer an easy access to the non-specialist.

R. Lüst underlines the recent actions taken by the European Space Agency to accept as coinvestigators on space mis-



### **ESO Guesthouse in Snow!**

*Many visiting astronomers remember the ESO Guesthouse in Santiago as a warm and sunny place to rest after a hard observing run or a long flight from Europe. Few, however, have witnessed snow on the ground. The photo was made in July 1990 by K. Fuhrmann (Munich).*

sions scientists from Hungaria, Poland, Czechoslovakia. P. Léna recalls a number of comments received during the Panel preparation phase, which all concern the high cost of scientific books, and express the hope that some efforts will be made to produce cheap (paperback), up-to-date fundamental books in astronomy for European students.

The available and future *Observing resources* in Europe constitute an important chapter. A. Boksenberg reads a letter from F. Sanchez, who outlines the exceptional opportunities offered by the Canarian site for long-term development of optical astronomy in the Northern Hemisphere and suggests the creation of an institution, similar to ESO, in the North. This view is challenged by several panel members, who would rather favour the development of ad-hoc cooperations, and not put available resources into monolithic schemes, which may then lose efficiency and slow down the emergence of new ideas. The cooperation within the VLBI may be taken as a good example of such flexibility. Some form of flexible association ought to be invented, which would allow the optimum sharing and use of observing resources, data and talents, but without leading to infinite extension of the membership in existing organizations. Funds provided by international structures, such as the EEC, could help to create this type of partnerships. On the individual basis, the status of "co-investigator" in a programme could also be

extended to scientists who do not belong to a "member state" of a given programme.

It is suggested that the new EAS may trigger an effort analogous to the regular Reports to the National Academy of Science in the US (the current Bahcall Report), in order to provide guidelines for the future plans. The other view is also expressed, that one should keep flexibility and not necessarily provide a unique plan for Europe, where the sources of funding are much more diverse than in the USA. Naturally, this must not restrict the absolute need for optimization of resources in the global sense. In this connection, A. Boyarchuk recalls that the USSR projects are open to participation to all European scientists.

The last item on the Panel agenda is *Communication of astronomy to the public*. Time prevents an extended discussion on this, but R. West briefly outlines how much work is to be done: planetaria, proper school education, clubs, TV programmes. He stresses the great differences from country to country, and the urgency for appropriate channels to be created for the transfer of public information across the borders as well as the desirability that "culture" as well as "astronomy" properly develop new interactions. He mentions the current agreement between ESA, ESO, CERN, EMBL to create a joint scientific exhibition that will tour Europe in the coming years.

P. LÉNA, Panel Chairman

# Hundreds of Rock Engravings Around the La Silla Observatory

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Astronomers on observational trips to the La Silla Observatory and the permanent staff can combine work and pleasure by making the most of the sunny days to take long walks on the mountains.

During these walks, they often discover strange rock engravings, sometimes very numerous, spread over the basaltic rock faces or on granitic blocks scattered on the soft slopes.

There are rock engravings all around La Silla, mainly on the eastern slope of the mountain, towards the locality called El Cementerio Indio, and in particular on the southern slope, on both sides of the Quebrada Los Tambos whose head is directly below the 3.6-m telescope. There are small groups of engravings on the western and northern slopes, but as yet little research has been done in these areas.

In early February 1990, we carried out a complete photographic and topographic survey of the engravings of the Quebrada Los Tambos and we partially explored those on the eastern slope. We compiled a photographic atlas of over 1000 black-and-white pictures and hundreds of colour slides. Several sets of contact prints were made, one of which was deposited at the library in La Silla, with an explanation of how the enlargement of the photos were made.

This article begins by giving a general idea of the geography and the history of this area, to help to situate the rock art and prehistoric sites of La Silla in relation to the ancient history of the Norte Chico. We then follow the paths in search of these hundreds of engravings, in order to look at them, describe them, define their specific style, identify their particularities, determine their distribution and attempt some interpretations. Finally, we compare the La Silla style with that of other known rock art sites in the region and elsewhere.

## The Geographical and Historical Context

In this semi-arid region of Chile where the European Southern Observatory has been set up, four major physical features can be distinguished from east to west: the high cordillera, the mid-altitude mountain range (where Cerro La Silla is situated), the wide valleys which cross them, and the coastal plain (1).

Cerro La Silla is situated in the basin of the Río Los Choros, which does not originate in the high cordillera, unlike the two major adjoining river basins, the Río Huasco in the north and the Río Elqui in the south. This explains why there is no permanent watercourse in the bed of Río Los Choros. However, it may be presumed that in the first millennium of our era, rainfall was more abundant than it is now. The presence of prehistoric sites around La Silla and in the surrounding area supports this hypothesis, and the flora was certainly more varied.

Chronologically, from the beginning of our era until 700 or 800 AD, the first culture in the semi-arid north was *El Molle*, named after the village of the same name in the Elqui valley (2). During this period, agriculture was carried on and pottery was produced. Then the El Molle complex was superseded by another culture, perhaps technically more advanced, called *Animas* (3). This lasted until about 1200 AD and gave place to the *Diaguita* culture (4). This culture reached its height towards the middle of the XVth century, when the Inca conquest came from Peru. The symbiosis of these two cultures resulted in the *Inca-Diaguita* period until the Spanish conquest led to wholesale destruction from 1535–1540 onwards.

The archaeological sites of La Silla have not yet been excavated, but based

on similarities between the rock art styles, it is generally accepted that the signs of human occupation at La Silla can be attributed to the El Molle complex. The Archaeological Museum of La Serena most attractively displays each of these cultural periods of prehistoric Norte Chico with many photographic documents and innumerable objects discovered during the archaeological excavations.

## The Rock Art Sites of La Silla

We begin our exploration of the east slope of Cerro La Silla at the dormitories near the Hotel. This is a gentle downward slope and we take the direction of El Cementerio Indio. After a few hundred metres, we come across two solar figures about 20 cm in diameter carved on a block of basalt. Turning to look back towards our point of departure, we see a beautiful string of white domes silhouetted against the deep blue sky.

Further down, at an altitude of about 2000 m, we admire a magnificent set of engravings on a vertical panel in three parts, facing south-east (Fig. 1). This triptych was obviously carved by a single artist and over a short period of time, because the patina is uniform. There are two scenes showing men and animals together and strange geometrical figures whose meaning escapes us.

Arriving at El Cementerio Indio, some



Figure 1.



Figure 2.

engravings are visible here and there, not far from a spring. The soil has been considerably disturbed by many illicit excavations. Following the quebrada downwards, we reach the Río Los Choros.

The site richest in engravings is beyond doubt that of the Quebrada Los Tambos. Almost all of this vast and gently sloping region can be observed from the outside catwalk of the 3.6-m telescope. Some years ago, this area was difficult to reach because of the steep slopes below the 3.6-m which had to be negotiated. Now the new road to Cerro Las Vizcachas saves time and energy. Figure 2 shows that the first groups of rock engravings are only one hundred metres or so below this road.

The higher part of the Quebrada Los Tambos follows a southerly direction and then gradually veers towards the east. A few hundred metres further down, it passes through a series of basaltic outcrops where some terraces

have been formed. Various stone tools can be found here (Fig. 3) with other signs of human occupation. From this level, the talweg of the quebrada again veers towards the east and gently slopes down to El Cementerio Indio which we have described earlier.

The majority of the rock engravings in this quebrada are seen on the thousands of granite blocks scattered over the western slope. Engravings are also found on the eastern slope, which is steeper and basaltic. The largest engraved surface in the region is on this eastern slope. Dozens of varied motifs cover the surface of a stone slab measuring several square metres. However, it is difficult to move back sufficiently to be able to photograph all of it.

On both slopes of Quebrada Los Tambos, we have identified and photographed a total of nearly 800 engravings. Continuing our path towards the south and east, we found other groups of rock art which we hope to be able to explore in the future. The engraving technique used by the Molle is direct picking out using a blunt point. The outline is sometimes clumsy and superficial, sometimes deep and carefully done. Unlike many sites in the United States and Mexico, no longitudinal lines produced by a repeated abrasive movement are found.

We continue our route towards Cerro Las Vizcachas beyond the area shown in Figure 2. Up to the right, we pass the SEST of our Swedish friends and one kilometre further on, to our left, we observe some dark blocks of stone one hundred metres lower down. Here we discover one of the most beautiful groups of engravings of La Silla, and perhaps the one which is most familiar to weekend walkers (Fig. 4). This could be termed a coherent set of engravings, since as in the case of the triptych on the eastern slope the work appears to have been carried out at one and the same time. The delicate central spiral

symbolizes a serpent, while the rest of the space is taken up by strange little figures, together with some simple geometric motifs and quadrupeds.

From this group of rocks, it is no longer possible to give a detailed itinerary, because engraved granitic rocks, isolated or in groups, are found in all directions. If we follow the contour line to our left, we come across the important site whose highest elements are shown in Figure 2. Heading directly east, we come to the important outcrop of basaltic walls of the bed of the Quebrada Los Tambos where the engravings are so numerous and so densely crowded that our heads spin! Almost every stone has an engraving and most of them have engravings on all their sides. The only advice we can give to the tourist is to follow a zigzag path and in groups to cover the area with a minimum of "misses".

Continuing our path towards the east, following the talweg, we come back to El Cementerio Indio. This path is also scattered with carved blocks of stone.

### The La Silla Rock Art Style

Above all, a rock engraving is a thing of beauty which gives pleasure to the eye. Their great variety, their size and the diversity of themes of which they are composed often make them authentic works of art, which are admired in the same spirit as paintings in a museum. Here at La Silla the passing of centuries can be felt at the site. Some rocks have been fissured by weathering, in others the surface has flaked due to thermal or chemical action and the drawings have been lost for ever. Over the centuries, the sedentarized population of the area, whose domestic life was based on agriculture and cattle rearing, carved new rocks or did new carvings over older ones. The differences in patina indicate that this practice was spread over long periods in time. As for the fundamental



Figure 3.



Figure 4.



Figure 5.



Figure 6.

purpose of this art, this is difficult to define. But there is no doubt that it is the most familiar elements of daily life that are represented here.

The engravings of La Silla can be divided into two well-defined groups, abstract and figurative designs. In the first group, which is by far the most numerous, a large quantity of geometrical signs are encountered, endlessly repeated: plain circles or circles with rays (internal or external), isolated, concentric or in series, plain rectangles or rectangles with internal parallel lines, spirals, stars, ovals, isolated or parallel undulating motifs, Greek patterns, maze-like designs. Figure 5 is a fine example of the geometric use of the undulating motif. The central element is a closed undulation which is often seen at La Silla (see also Fig. 2). Figure 6 is different in conception as it shows numerous surface elements, isolated from one another, and with internal parallel lines.

One particular type of engraving is very common here. The surface of the rock is covered with a maximum of details so as to leave no free space. A fine example of this form of graphic expression, which could be termed an "integral structure" is shown in Figure 7, where it is difficult to determine any guiding prin-

ciple in this jumble of circles, curves or segments. This rock is situated very near the road to Las Vizcachas, at level with the SEST.

The figurative drawings, fewer in number, mainly depict human outlines and animals. The anthropomorphs generally have a simple structure, a few lines representing the limbs and a dot for the head, but sometimes the style is more elaborate. The body is marked by thick lines, feet and hands are portrayed with toes and fingers, the head has a mask and bears a large ceremonial head-dress. This type of figure can be seen on the right in Figure 8. Its head is framed by four large dots and is surmounted by a feathered structure. The rest of the surface bears a tortuous network of irregular lines. Figure 9 is extremely interesting as it shows a highly stylized human form, identifiable by its two small eyes and the two hands with five fingers. Stylized representations of this kind are very rare at La Silla. This carving is located on the eastern slope of Quebrada Los Tambos.

Animal shapes are very numerous and camelidae can be identified by their long necks. Often, the animal is depicted near a human figure and we are in presence of a domestic scene. The extreme

abundance of such motifs is an argument in favour of the essentially pastoral nature of the Molle populations which occupied these sites at the beginning of the modern era. The very pretty scene in Figure 10 has the most plentiful animals of the entire site, nearly 25 animals and some human figures, very certainly shepherds. In other engravings, animals follow each other quietly in line . . .

Another animal frequently represented is the serpent, depicted as a wave-like form ending in a large dot. Curiously, one never now comes across serpents when walking in this area.

We will end this description of the La Silla rock art style with the two anthropomorphs shown in Figure 11. Two figures can be seen, whose morphology is distinguished by a "thick" body, i.e. a certain area of the rock has been hollowed out by repeated impacts. They have neither hands nor feet, but on their heads they bear respectively 6 and 3 rectilinear or curved ornaments, perhaps feathers. Their style is unique at La Silla and they bring to mind representations of shamans. Such figures are common throughout pre-Columbian America. This scene is located near the road to Cerro Las Vizcachas, not far from the cerro, on a small mound a few



Figure 7.



Figure 8.



Figure 9.



Figure 10.

dozen metres away on the right. We would like to thank Mr. Scardia for taking us there. We also walked around the mound and saw that the two shamans enjoyed a splendid isolation, untroubled by the presence of any other engraving . . .

### Rock Art in the Norte Chico

Between Río Copiapó to the north and Río Choapa to the south, 200 archaeological sites belonging to the El Molle complex have been identified (5). Rock art is in evidence at 43 of these sites. This indicates the importance of this art form, which by its very nature withstands the passage of time.

The greatest El Molle rock art sites are found in the basin of the Río Limarí, in particular along the Río Hurtado in the north and around the town of Combarbalá in the south. The *Limarí* style is characterized by the wide variety of heads wearing masks or extravagant ceremonial head-dresses. Only one example of this type of engraving is seen at La Silla. The most representative site

of the *Limarí* style is the El Encanto valley, 19 km from the town of Ovalle in the province of Coquimbo. Some of the most beautiful examples of rock art in Chile can be admired there. The representations of gigantic human heads, rectangular in shape, bearing wide and complex adornments, are deeply engraved in regular furrows obtained by a remarkable longitudinal buffing.

The La Silla style thus seems to be well delimited in semi-arid Chile, between latitudes 27° S and 32° S, with some perceptible differences between the north (Copiapó and Huasco) and the south (Elqui and Limarí).

Another well-known rock art site gives an opportunity for more detailed comparison of styles and symbols. This is the site in Quebrada Las Pintadas de Marquesa, a northern tributary of Río Elqui, where over 500 engravings have been recorded (6). Comparison with La Silla leaves no doubt as to the similarity between the styles: the same invariants, the same human and animal figures, the same engraving technique. However, decorated heads are relatively numer-

ous. This important symbol of rock art thus shows a distinct progression from north to south, between La Silla where it is practically absent, the Quebrada Marquesa where it becomes more frequent, and the Limarí basin where it is omnipresent.

### Acknowledgements

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Figure 11.